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Title:

Terra Preta de Indio of the Amazon: opportunity to study black carbon dynamics in soil

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Abstract:

Terra Preta de Indio are very fertile soils that can be found throughout the Amazon Basin. They are particularly rich in carbon, phosphorus, calcium and micronutrients and possess higher cation exchange capacity (CEC) per unit C than surrounding soils. It has been established that these soils are anthropogenic dating from 500-2500 B.P., but it is still unclear whether they are the result of habitation or intentional soil management by Amerindian populations. The key to their high and stable C content and nutrient retention is the large amounts of black C. Soils near Manaus were found to have 5-10 times more black C than adjacent Oxisols. The occurrence of soils rich in black C neighboring soils with low amounts of black C is an ideal opportunity to study black C dynamics in soil. This has relevance for soils on a global scale, since black C was found in all soils where the appropriate analyses have been performed. While the longevity of black C is not yet clear, the changes in properties are virtually unknown. We investigated the properties of black C using synchrotron-based C (1s) Near-Edge X-ray Absorption Fine Structure (NEXAFS) spectroscopy to detect structural changes of black C over long periods of time. NEXAFS provides the opportunity to study the surface properties of black C particles that are as small as 10-40 micrometer. Stack spectra of cross-sectional areas revealed more carboxylic groups on surfaces of black C than in the center. A higher oxidation of surfaces would explain the greater CEC found in these soils. However, the amount of carboxylic groups on black C surfaces did not exceed those found on non-black C particles. A relatively high aromaticity after thousands of years of exposure to microbial and abiotic oxidation is an indication for the high structural stability of black C even under humid tropical conditions.

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